

Digital Tectonic Activity Map (DTAM) of the Earth: A Polar Perspective

Lowman, P., Principal Investigator

Yates, J., SSAI

Nazarova, K., RITSS

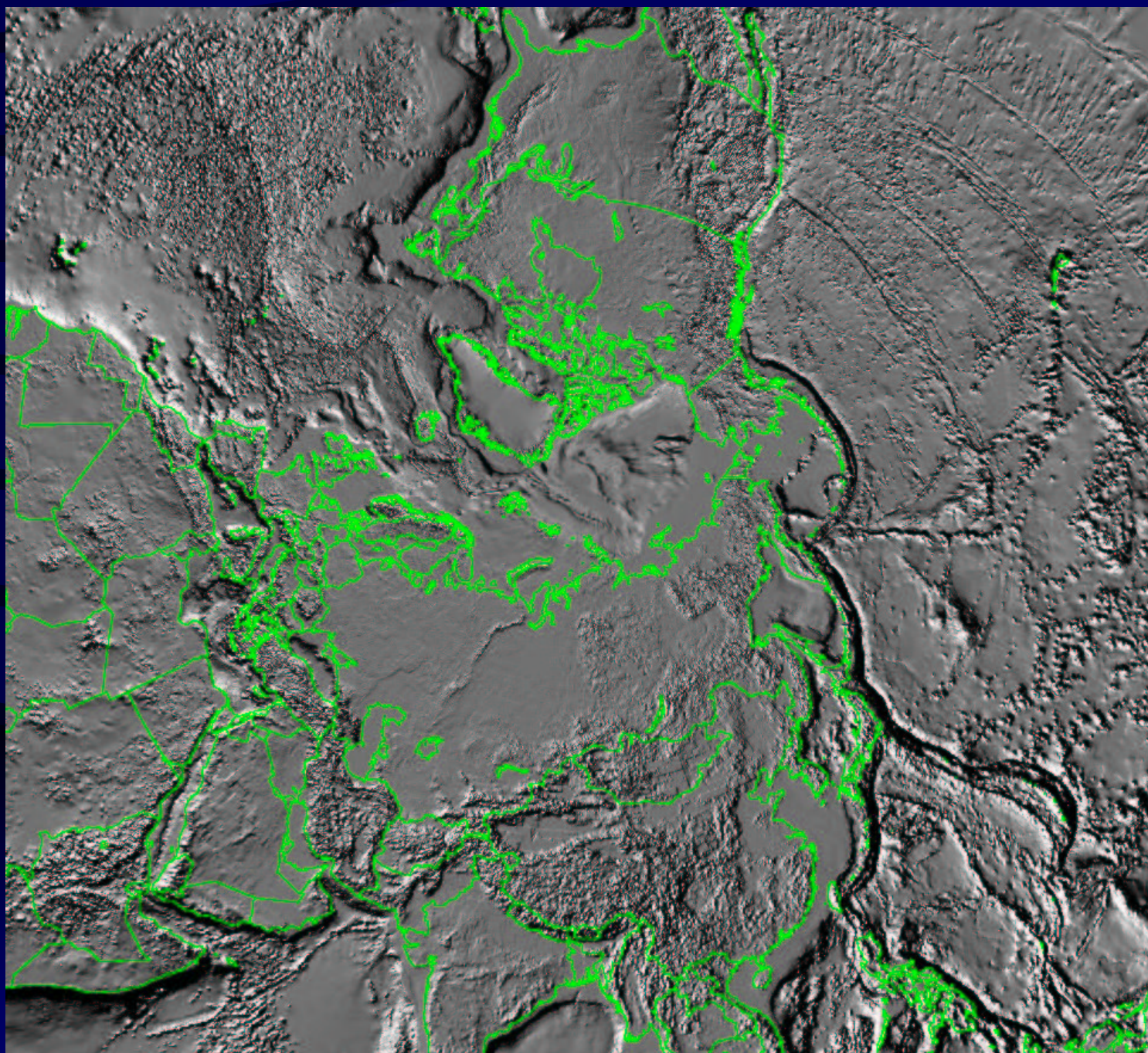
Geodynamics Branch, Mail Code 921, NASA-Goddard Space Flight Center

Abstract

Conventional plate maps, designed to illustrate plate tectonic theory, have proven too generalized to present a realistic view of global tectonic and volcanic activity. For this reason, we have compiled a digital tectonic activity map (DTAM) of the Earth, using the Robinson Projection, that shows major volcanic and tectonic features active within the last one million years. This period was chosen as being long enough to be representative of the geologic "present," but short enough that geomorphic features such as fault scarps and volcanoes are still recognizable, especially on orbital photographs. The DTAM is based on published literature, orbital photography, satellite radar altimetry, seismic epicenter maps, and space geodesy data. It has six parts: shaded relief, schematic tectonic and volcanic activity, seismic epicenters (events over 3.5 Mb) of equatorial and polar regions, and space geodesy measurements of site motion. Comparison of the DTAM with the World Stress Map shows previously unnoticed anomalies in apparent site motions in western Europe. These site motions indicate uniform plate motion to the northeast, at right angles to the principal horizontal stress directions expressing ridge push from the northern Mid-Atlantic Ridge. This anomaly probably results from choice of a geodetic reference frame for tectonic models, but should be further investigated. The DTAM is available on the Internet at <http://core2.gsfc.nasa.gov/dtam/>

Northern Hemisphere:

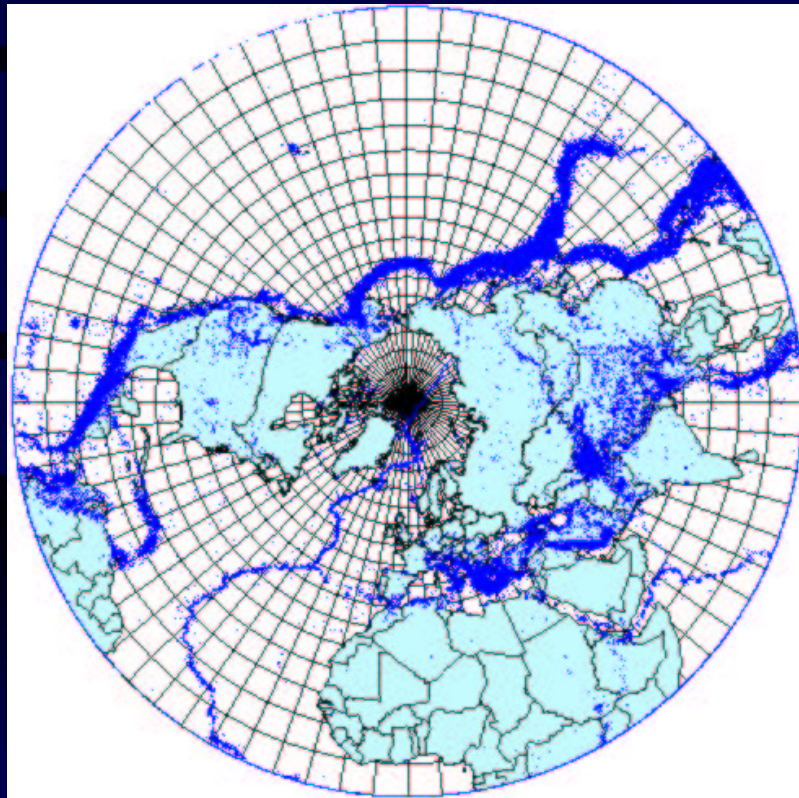
¥ Shaded-Relief Topography
¥ Derived via Radar and Gravity
¥ 9 km resolution



Results: North Polar Tectonics

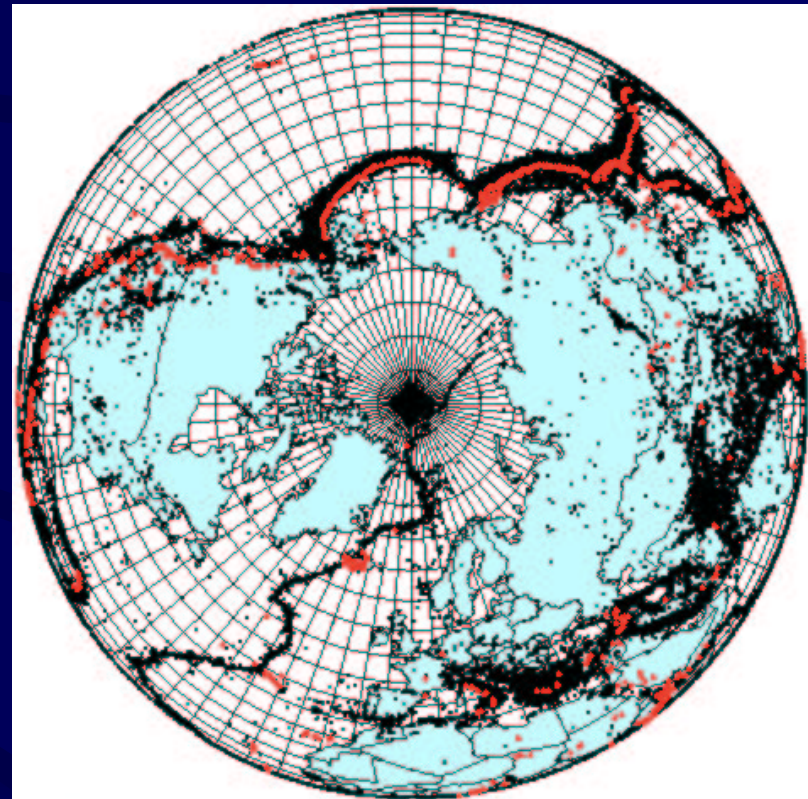
Conventional plate maps generally do not show high latitudes. This deficiency is especially important for the north polar regions. The DTAM shows several aspects of northern tectonics requiring further study. The position of the North American and Eurasian plate boundary in Siberia is shown clearly in relation to the Nansen-Gakkel spreading center under the Arctic Ocean, and hence to the world rift system. However, the non-congruent margins of the circum-Arctic continents are not easily explained in terms of conventional plate tectonic theory. Another problem illustrated by the DTAM is that site motion vectors in northwestern Europe, as measured by VLBI, appear to be parallel to the Mid-Atlantic Ridge. If ridge push is responsible for the southeasterly maximum compressive stress discovered by the World Stress Map Project, one would expect site motion normal to the ridge, i.e., to the southeast rather than the northeast. This anomaly may result from choice of reference frame in the NUVEL-1 plate velocity model, but should be studied. However, the DTAM does support the ridge push concept in that the relation of the Mid-Atlantic Ridge to North America and western Europe explains the broad areas of uniform compressive stress.

Northern Polar Projections



Stereographic Projection:

¥ Seismic Epicenters
> 3.5 Magnitude
1963-1998

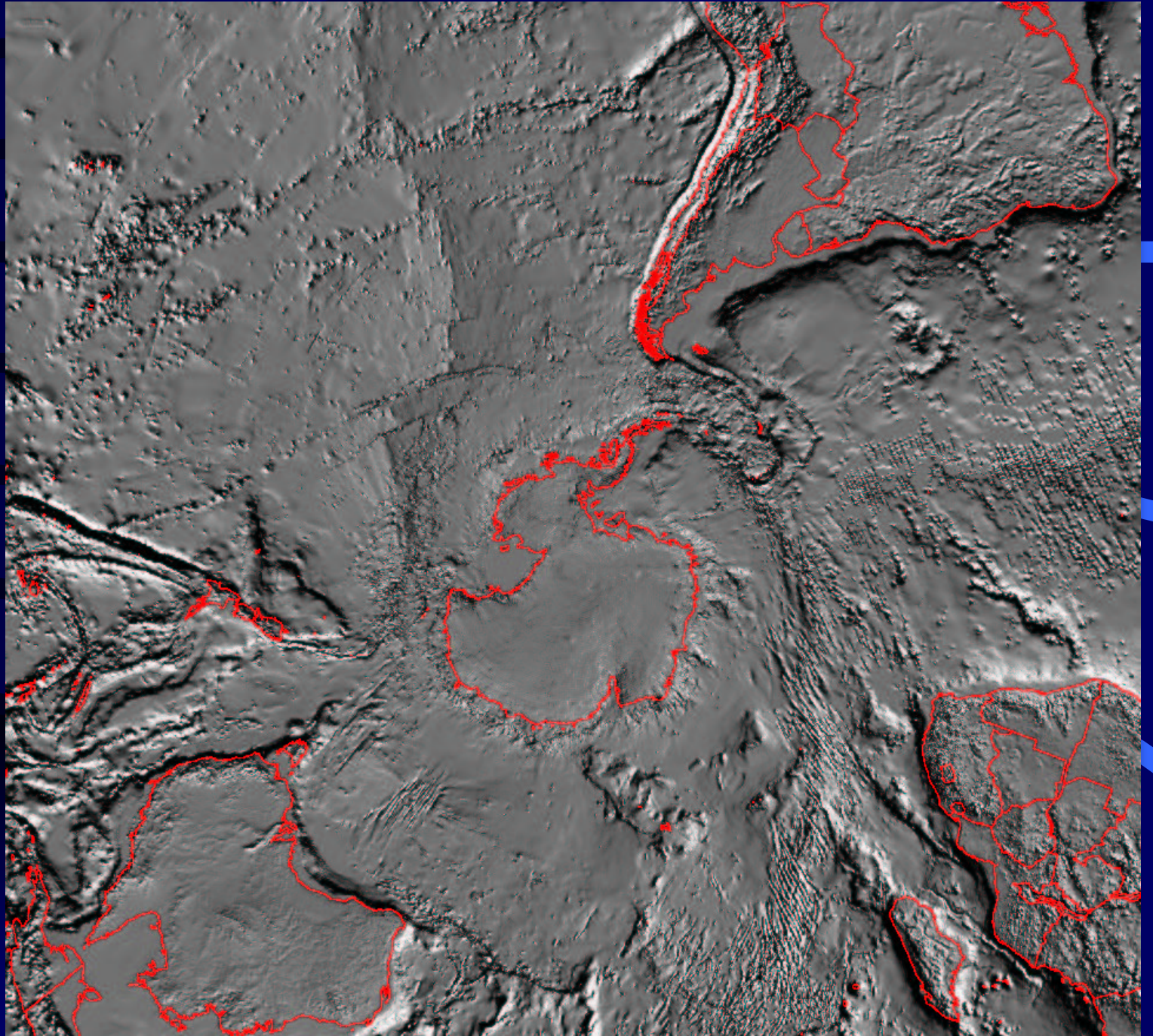


Orthographic Projection:

¥ Volcanoes (< 1 Ma)
¥ Seismic Epicenters
> 3.5 Magnitude
1963-1998

Southern Hemisphere:

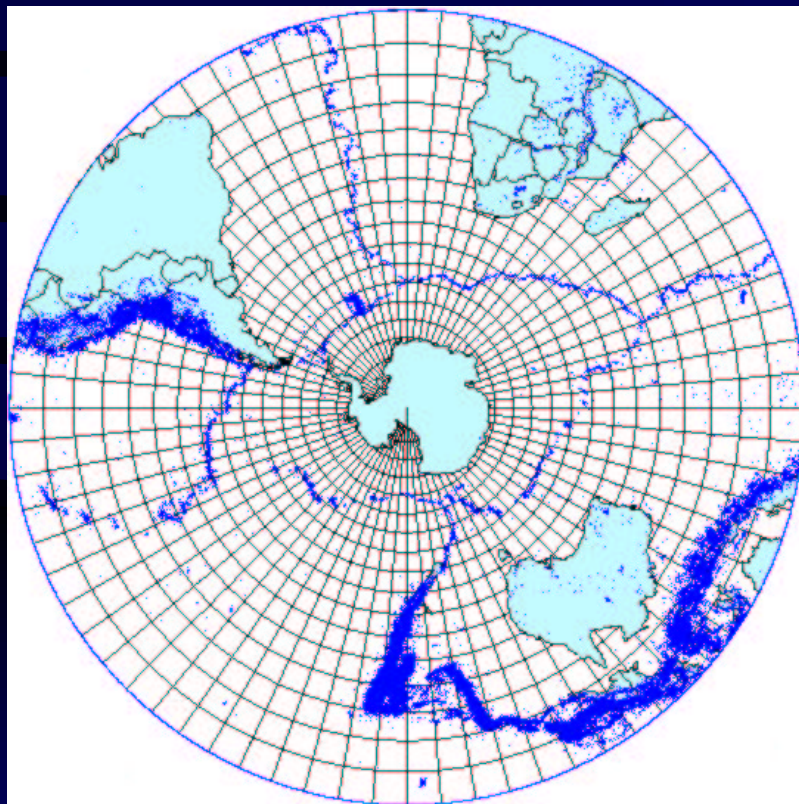
¥ Shaded-Relief Topography
¥ Derived via Radar and Gravity
¥ 9 km resolution



Results: South Polar Tectonics

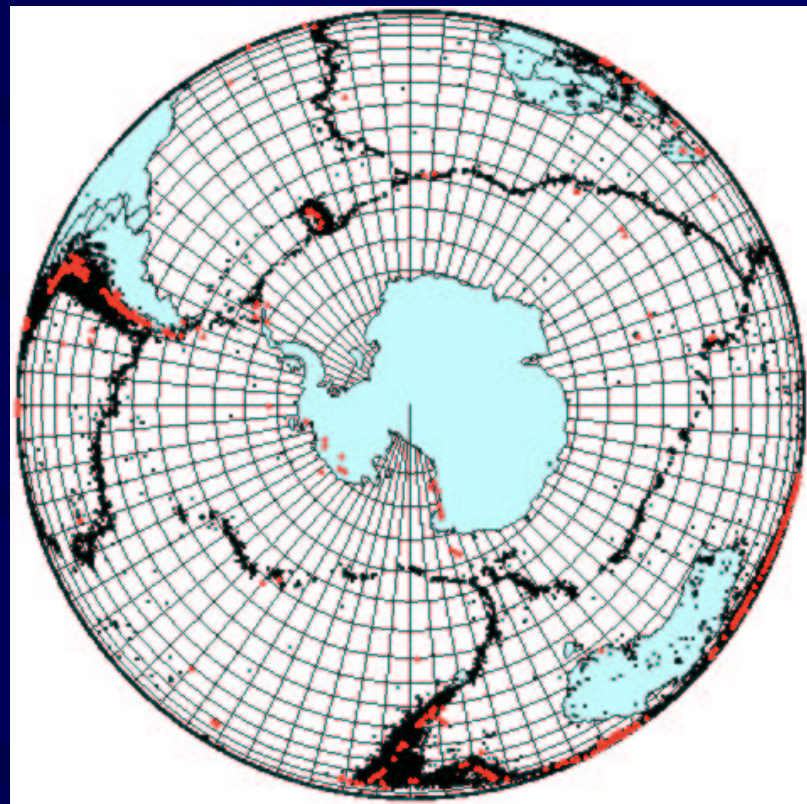
The DTAM shows several interesting aspects of the south polar regions, starting with the obvious but rarely-discussed fact that these regions are centered on a continent rather than an ocean basin, the opposite of relations in the north polar regions. Antarctica is shown to be surrounded by spreading centers, yet there are no subduction zones recognized under its margins. This anomaly is emphasized by the existence of a surprisingly well-defined though broad zone of young (< 1 Ma) volcanoes in west Antarctica. The nearly complete absence of seismic activity in Antarctica is shown, and it can be speculated that this is in some way related to the belt of circum-Antarctic spreading centers. The DTAM should be of educational value by avoiding the prevailing over-emphasis on equatorial regions typical of conventional plate maps.

Southern Polar Projections



Stereographic Projection:

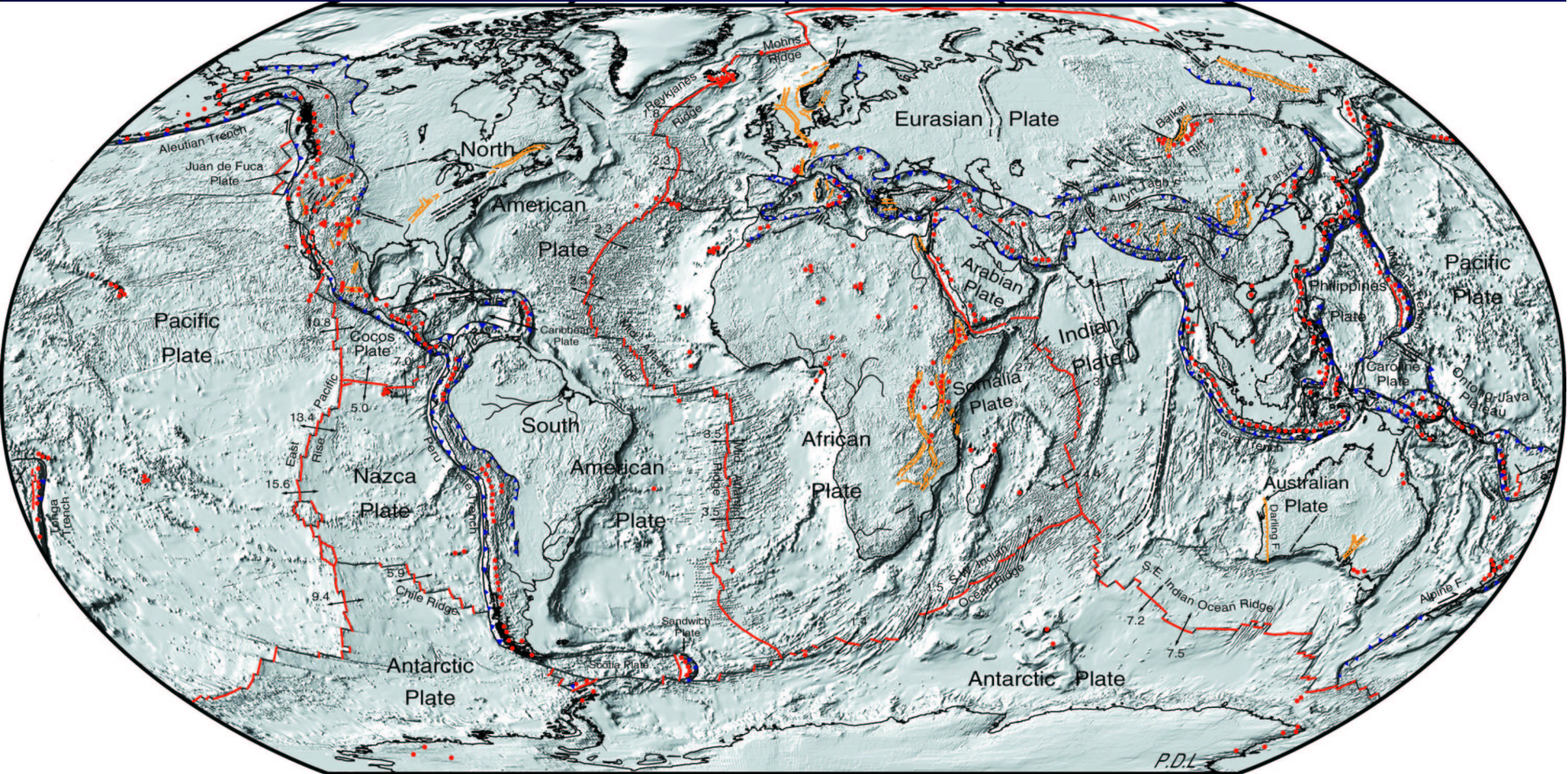
¥ Seismic Epicenters
> 3.5 Magnitude
1963-1998



Orthographic Projection:

¥ Volcanoes (< 1 Ma)
¥ Seismic Epicenters
> 3.5 Magnitude
1963-1998

DTAM: Robinson Projection (Atlantic-Centered)



NOTE: hardcopies available for download at:
<http://core2.gsfc.nasa.gov/dtam/downloads/>